UNIVERSITY OF TARTU

Faculty of Social Sciences

School of Economics and Business Administration

Alexander Katamadze

RELATIONSHIP BETWEEN LONG-TERM GOVERNMENT BOND YIELD AND ECONOMIC GROWTH RATE

Bachelor Thesis

Supervisor: assistant Mark Kantšukov

Tartu 2021

I have written this Research paper/Bachelor Thesis independently. Any ideas or data taken from other authors or other sources have been fully referenced.

Table of contents

Introduction

Within the field of economics, there are countless instances of different variables, indicators, and indexes, having an empirically observable relationship with each other. The nature of these relationships can from being simple correlations, one variable could have predictive powers over another or vice versa, and so forth. A topic often studied is the relationship of economic growth rate with another variable. Examples include studies that examine relationship of economic growth and economic inequality (Shin, 2012), valuation of real exchange rate (Ribeiro, McCombie & Lima, 2019), and interest rates (Shaukat, Zhu & Khan, 2019).

A common variable studied against economic growth by researchers is the stock market and its returns. Ritter (2012) looks into this question, specifically looking at the correlation between growth of GDP per capita and real stock returns of nineteen, mostly developed, countries with extensive stock market history, and found the correlation to actually be negative, although not strongly so. Another paper, this one by Masoud (2013), examines the stock market as a catalyst for economic growth, and finds that the extent to which stock market contributes to the economy is dependant not just on its returns, but on how well it relays information and distributes risk. While not a direct endorsement of Ritter's findings, it still follows the trend of not ascribing the growth of the economy to equity market's rate of return.

Stock market is but a part of the capital market within the financial world. The other part of the capital market is made up by the bond market which, despite comprising of the other part of capital market, is not studied as often as the stock market, especially with regards to its importance to the economic growth. Thumrongvit, Kim & Pyun (2013) found an existing positive relationship between the government bond market and the economic growth, opposite of what Ritter (2012) found for equity markets. But furthermore, they themselves pointed out the lack of proper inclusion of bonds in similar studies, which prevents the formation of a consensus within the academia about which side of causality bonds stand on. This sentiment is mirrored by Pradhan, Arvin, Bennett, Nair & Hall (2016), repeating that current studies on economic growth do not consider the bond market despite its importance. And later, Pradhan, Arvin, Norman & Bahmani (2018) revisited the question, delving further into it, and maintaining the stance that bond markets are important yet ignored.

Similar to the capital markets divide, there is a bond markets divide between corporate and government bonds. While quite alike, there are notable differences, many of

which can be summarized as corporate bond market being closer to equity market than government bond market is, and corporate bonds having shorter duration. To provide an analysis that overlaps with equity market the least and is complementary instead, the paper will discuss long-term governmental part of the bond market only.

As shown, the relationship between bonds and economic growth is an important one and necessary to take into consideration for any proper analysis of economic growth. Conducting a study in which it is tested how well bonds can predict the economic growth rate has its own problems and would be going against the very literature discussed as they claim that unless all variables are used in the model the results will be skewed. It could also be argued that taking the study into the opposite direction, showing whether or not past economic growth rates or future forecasts impact the decision of policymakers when they set the bond rates will also yield incomplete results as the quantitative analysis can only show whether there was a correlation, but cannot confirm that policymakers were actively affected. Lastly, going back to the Thumrongvit, Kim & Pyun (2013) study, there is no consensus yet which of these two variables predict the other, so this paper will concern itself only with the correlation.

Finally, as changes to the economy occur everywhere, countries considered in this paper will be the ones that are known for their sizeable government bond market.

Research aim of this paper is to find out the strength and the direction of the relationship between economic growth rates and yield rates of 10-year government bonds by examining a panel of 15 OECD countries over the time period 1995-2019.

To achieve this aim certain tasks will be completed, specifically:

- To review the relationship between public debt and economic growth from a macroeconomic perspective,
- To define bond market and its important characteristics,
- To explain the connection between government yields and economic growth rate based on approaches described in existing literature,
- To discuss the data and methodology,
- To characterize the data with descriptive analysis and conduct assumptions test necessary for empirical analysis,
- To conduct an empirical analysis examining economic growth rate and long-term government bond yield and relate them to the findings of literature review.

This research paper will consist of three subchapters in its theoretical part, and three in its empirical part.

The first subchapter of the theoretical part will concern itself with theoretical implications public debt can have on economic growth. Given that bonds are a debt instrument, and government bonds are issued by the state to acquire financing at the cost of increased public debt, discussing it is a crucially important step in an effort to create the basis on which a proper discussion about bonds can be built.

The second subchapter of this paper will move the discussion in the direction of sovereign bonds themselves, beginning by considering the topic of bond markets and its main characteristics such as capitalization levels, and development rate. What are the main determinants and which variables interact significantly with the economic growth rate, and how different is the relationship between growth and bond market, as opposed to the overall public debt.

In the third subchapter the discourse will be mainly about the long-term bond yields themselves, albeit mostly in the form of yield curves, and the literature will be examined to determine the strength of the relationship and also to offer a review of different hypotheses about the nature of this relationship offered by authors so far, such as causality and predictability. The second half of this work will be concerned with the empirical part, which will most obviously begin by explaining the chosen variables, why were they chosen and exactly what form they will take. Furthermore, the methodological methods will be properly introduced.

Before moving onto the actual analysis, data will be further explained with the use of descriptive statistics and necessary assumption tests will be conducted. The results of these descriptive analyses will help further explain the methodological justifications,

The next step will be conducting the empirical analysis, which will be multi-faceted and include both basic and more complex tests, so as to examine different potential relationships the variables may have.The final subchapter will be concerned with interpreting the quantitative findings, explaining what is significant and what is not, and most importantly relating the results to the reviewed literature so as to see which trends held true in this paper and which one did not, but also to help in the interpretation process.

Finally, all the results of the paper will be briefly concluded at the end.

Keywords: economic growth, bond market, government bonds.

1. Theoretical review of economic growth rate and the government bond yields.

1.1. Public debt and economic growth rate

Discussing government bonds and their relation to the economic growth rate by only focusing on figures and numbers, like the volume of bond market, yield rates, and so forth, is disingenuous as it ignores the core of what government bonds represent, and that's government debt. It can also be referred to as sovereign debt, public debt, national debt. This debt does not necessarily equate to the total value of outstanding bonds issued by the government, as institutions such as IMF and World Bank offer direct loans to nations, along with other sources of debt financing that governments have access to, but nevertheless the concepts of public debt and government bonds are closely linked. Discussing the effects of public debt on economic growth rate from a theoretical standpoint can create a solid groundwork for the follow up discussion about bond market and bond yields.

In their paper, Sutherland & Hoeller pointed out that debt brings various risks with itself and interacts with macroeconomic variables. Balance sheet issues of debt are secondary to the question of this research paper, because those issues are concerned with private debt of individuals and enterprises, however government debts are not without consequences either. They can lead to behavioural changes among households due to change in both the expectations of savings, as well as the actual realised value of kept savings. Furthermore, the attempts of the state to fix one problem, such as aggregate demand, may backfire if the funding for the solution was acquired through debt financing. It could increase interest rates and deter investor actions which would have expanded the economy. (Sutherland & Hoeller, 2012)

One must also consider the reasoning for government to borrow money. It follows that if government is taking on debt, it is due to them requiring financing. While states collect revenue from taxation, that alone is never enough for national budgets. Furthermore, in times of emergencies debt is far more convenient – if it is a recession that is being handled, then one could expect that economic activity is in fact down, further decreasing tax revenue. But even if that were not true, when a government requires billions of euros to proceed with the project immediately, tax programs are not enough. A real-life example of such scenario is the European Commission's decision to raise €100 billion by issuing social bonds to help European nations fight against the economic downturn brought by the COVID-19 pandemic (Hirtenstein, 2019). In other words, national debt, at least in theory, is a tool that governments can use to act countercyclically when necessary, something that Sutherland & Hoeller (2012) also agree with. However, a report by OECD (2012) concludes that high debt levels may lock

fiscal policy into a procyclical behaviour, meaning that in a recession, such as the one caused by COVID, not only would government fail to minimize the harm but its failure to keep debt levels low would only make the economic hit hurt even more. In short, debt may accentuate the very problem that it was supposed to be a solution for in the first place, and drastically change the impact of a recession on economy for the worse.

However, the threat that any given level of debt may pose on the growth of economy must scale with the economy itself. Therefore, it is not some specific nominal value of debt that must be treated as the acceptable ceiling, but rather a relationship between debt and GDP must be established. Caner, Grennes, and Koehler-Geib (2010) do exactly this by testing the impact of public debt to GDP ratio on the growth of economy and found that rate of economic growth starts suffering once the level of this ratio crosses the threshold of 77% for developed nations, and only 64% for developing nations. While the study itself was brief and concerned directly with this issue, not with underlying mechanics, it would not be improper to speculate upon the reasons for this noticeable difference. It is possible that due to the national debt interacting with many variables it becomes harder for nations without strong institutions and well-developed markets to bear the burden of debt, thus the significantly lower threshold for such nations. This explanation would also more or less fall in line with the findings of Sutherland and Hoeller (2012) discussed before but is also further supported by the Inter-American Development Bank study. Calderon and Fuentes (2012) found a robust and negative relationship between the level of public debt and economic growth, but they also noted the non-linear nature of this relationship which could support the existence of thresholds, and the impact strong institutions, markets, and high GDP have on reducing the negative effect of public debt which supports variance of threshold between richer and poorer countries.

A particularly thorough study was conducted regarding public debt and growth. It analysed 38 developed and developing nations, all of them with a population of over 5 million so as to ensure a decently sized economy, over the course of nearly four decades, 1970-2007 period. Not only is the panel of the countries more than satisfactory, but the choice of period is also very useful as it shows a long-term effect before the Great Recession. This means that the study provides an accurate image of relationship between debt and economic growth before the major financial crisis of 2008 could affect it, something that not many studies provide. The findings of this paper, written by Kumar and Woo (2010), are that a growth in initial level of debt-to-GDP ratio had a negative impact on the speed of growth in the future. But it is interesting to see that the extent of this negative impact was actually

found to be lower on poorer countries. On the other hand, this paper, like the ones discussed before, noted a non-linear relationship between the two examined variables.

The paper by Baldacci and Kumar (2010) worked also to investigate the relationship between debt and the national economy, but what makes that paper special with respect to this thesis is its chosen variables and consideration of bond yields and interest rates in the equation, and the effects those variables experienced. The main conclusion of the paper was that the level of public debt affected the extent to which deficits and fiscal issues would impact the interest rates and long-term government bond yields. This relationship was positive, meaning that higher levels of initial debt level resulted in higher changes to the interest rates and long-term government bond yields. The two takeaways that further elaborate on the situation were that other variables, such as FDI and global bond market, were not as important, and that the relationship was found to be highly non-linear. It should be noted that in this study, even though bonds and debt were yet again being tested, the specific variables and methods employed were different from the ones previously discussed, yet the trend of non-linearity persisted.

These studies establish that public debt, of which the bond market is a vital component of, has a well-documented impact on the economic growth rate. Specifically, the authors all argue that increase in debt also increases risks of a slowdown of economic growth rate. Even when different dimensions and derived variables were used, non-linearity was a common finding. Given that the modern-day status quo is that of debt economy with almost every developed nation utilizing debt to a certain extent as its source of financing, it does not come as a surprise that up to a certain level debt can be tolerated by economies without suffering too much. While countries are wary of taking too much debt for a good reason, they still continuously choose to operate with it and have been designing their policies with sovereign debt in mind.

However, as is common with macroeconomic variables due to the vast amounts of interactions, the causality is not a simple matter. While the papers above stated that it was the debt that affected the economic growth, they did not question this as much as the authors assumed it to be true and then simply examined the extent of this impact. In a similar fashion, but with an opposite assumption, Sadik-Zada and Gatto (2019) conduct a study where they construct a linear regression model to estimate the impacts of different macroeconomic variables on public debt. Their findings were that higher rates of GDP growth have a reductive effect on the debt-to-GDP ratio, however this effect was negated among the developing countries. Another noteworthy finding was the positive effect interest payments

had, meaning that higher interest payments on the public debt cause the debt itself to rise. This is a relevant point to this thesis as sovereign bond yields are also the interest rates that the government is willing to borrow funds at. Over the last few decades, a trend of consistently lowering the government bond yield has become quite established, especially among the OECD countries, which would logically bring down the total public debt as the overall interest payments ought to be lower. Combined with the findings of previously discussed literature which stated that debt-to-GDP ratios that exceed certain thresholds hurt the speed of economic growth, and findings of Sadik-Zada and Gatto (2019), one may posit that this western trend may unintentionally be a measure that is preventing the economic growth to slow down. A similar result was obtained in the paper written by Gargouri and Ksantini (2016), in which literature was examined to identify potential determinants of public debt and form a hypothesis, which was later tested through a panel linear regression. In this paper, the authors found GDP growth to have a strong and negative impact on the debt-to-GDP ratio, even stronger than the impact of lagged debt values which would indicate that even the intransigence of sovereign debt is overshadowed by economic growth's capability to affect the level of sovereign debt. The findings of these and previous papers about relationship directions are presented in Table 1.

Table 1

Relationship directions between growth and debt

Author	Region(s) Studied	Variables	Direction of relationship
Caner, Grennes, & Koehler-Geib (2010)	101 countries worldwide	public debt-to-GDP ratio and economic growth	Negative above a 77% threshold; 64% for developing nations
Calderon & Fuentes (2012)	136 countries worldwide	level of public debt and economic growth	Negative relationship
Kumar & Woo (2010)	38 advanced and developing nations worldwide	level of initial debt-to-GDP ratio and economic growth	Negative; Strong in richer countries
Sadik-Zada & Gatto (2019)	184 countries worldwide	GDP Growth and debt-to-GDP ratio	Negative; Weak among developing nations
Gargouri & Ksantini (2016)	12 European countries	GDP Growth and debt-to-GDP ratio	Negative

Source: compiled by author

As it can be seen, the relationship between growth and debt-based variables are overwhelmingly negative, but factors such as wealth of the nation can have an additional effect on it. The flaw, if one may even refer to it with that word, of these studies is that, as previously mentioned, they engage the topic with strong assumptions already made. The authors of articles described in this part of the paper have conducted research trying to find out what is the impact of public debt on GDP growth, or vice versa. But so far none of the papers went to proper lengths to establish if the variables truly had causality effects on each other, instead of it being a product of correlation. Ferreira (2016) does just that, analysing economic growth along with all sorts of debt through causality testing, specifically in the EU region. Their findings were that public debt had a positive impact on economic growth, which challenges the results brought up previously in this paper. For this, the author also offered a theoretical explanation of this through the Keynesian approach, something that was further justified by the fact that this relationship was at its peak strength in the period immediately after the Great Recession. However, the causality was actually found to be bidirectional, with the rate of economic growth having a negative impact on the level of debt. In other words, this paper showed that in the period after a crisis debt be a useful financing tool fuelling the growth of economy. But as time goes and economic growth accelerates, fewer and smaller deficits occur, and the public debt starts to shrink. But since this finding was mostly observed during the post-crisis period, this relationship cannot be generalized to the long-term view. Furthermore, the countries examined were all from EU, which as a sample is overwhelmingly dominated with wealthier and developed economies, thus not being representative of the global economy. But this theory nevertheless is backed by other researchers. Abdelkafi (2016) and Egbetundde (2012) examined the African nations of Tunisia and Nigeria, respectively. They both found the causal relationship to be bidirectional, and Egbetunde (2012) also commented on public debts' ability to actually boost the economic growth when managed with intentions to actually develop the national economy. But this topic is far from reaching a consensus; Jacobs, Ogawa, Sterken and Tokutsu (2019) explored this topic analysing data from 31 countries – 27 EU members, all but the youngest member Croatia, as well as 4 of the largest non-EU member OECD countries. While they found changes in economic growth had a causal effect on debt, they rejected the notion that the inverse was also true, and that bidirectional causality existed between these variables. They also found the relationship to stay more or less the same at different debt levels, rejecting non-linearity of the relationship. And finally, the paper by Donayre and Taivan (2017) muddled the waters even further by conducting a country-by-country study of the 20 OECD countries over a

period of four decades and associating the causality with government structures. Specifically, their paper stated that debt-to-GDP ratio had a causal effect on economic growth in countries with limited intervention into the economy, but in established welfare states either the opposite was true, it was the growth that had causal effect on the debt, or sometimes a prominent bidirectional causality was detected. Table 2 summarizes these articles and their findings regarding causality in a simple to read format and showcases how results vary from author to author and region to region. Methodology information was not added to the table as they all used Granger or Panel Granger causality test, so there was nothing to differentiate.

Table 2
Summary of causality findings

Author	Studied region	Causality result
Ferreira (2016)	28 EU countries	Economic Growth ← Private Debt Economic Growth × Foreign Debt Economic Growth ↔ Public Debt
Abdelkafi (2016)	Tunisia	Economic Growth ↔ Public Debt
Egbetundde (2016)	Nigeria	Economic Growth ↔ Public Debt
Jacobs, Ogawa, Sterken & Tokutsu (2019)	27 EU + 4 OECD countries; panel approach	Economic Growth → Public Debt
Donayre & Taivan (2017)	20 OECD countries; country-by-country approach	Economic Growth ← debt-to-GDP ratio* Economic Growth → debt-to-GDP ratio Or Economic Growth ↔ debt-to-GDP ratio **

Notes. * For countries with non-welfare state model

** For countries with welfare state model

Source: compiled by author

The literature reviewed up to this point has established several trends. While the importance of sovereign yields is not oft mentioned within the conversation around the public debt, occasional articles such as the one by Baldacci and Kumar (2010) provide interesting commentary on the subject. More importantly, these articles showed that the relationship between debt and economic growth is generally consistent in strength, direction, and its non-linearity, even though the specific variables used differ, signalling that similar trends may repeat themselves as the discussion moves towards bonds and not debt as a whole.

1.2. Bond market, its development, determinants, and impacts

Many key academic works that research the relationship between bonds and economy, including the studies highly relevant to this paper, written by Pradhan, Arvin, Bennett, Nair & Hall (2016), Fink, Haiss & Hristoforova (2003), and plenty of others others, all have one thing in common. And that thing is that when they discuss bonds, they do so by talking about

bond market development, and not about other aspects such as average duration of a bond within the market, bond yield and coupon rates, or their nominal prices. Therefore, it is important to understand what exactly bond market development encompasses as otherwise swathes of important literature would be ignored.

One of the explanations given for the term is, as follows – *"Bond market development represents the intensity of public, private and international bond markets"* (Pradhan, Arvin, Norman & Bahmani, 2018, p. 177). In other words, development of a bond market means the growth of the bond market in size and value. While this happens on an almost daily basis for the equity markets, there is no basis to expect bond market to behave in the same fashion. Instead, to look at why bond markets behave the way they do, its determinants must be examined. Knowing which variables affect the bond market can prove useful when researching how bond market and economic growth, as variables, affect each other.

Eichengreen & Luengnarumitchai (2004) looked at the determinants of Asian bond markets so as to answer the question of why they were not larger, despite the theoretical potential some believed Asian nations had. Their finding was preceded with the statement that the factors were undeniably multiple, meaning that bond markets are indeed affected by determinants and not one major factor. Their list consisted of concepts such as English legal origin, country's dedication to following international standards of accounting, size of total GDP. Rather interestingly, macroeconomic policy was also outlined as a significant determinant, with the emphasis on the fact that stable exchange rates helped bond market develop, but government budget balances were not as big of a factor as expected.

Mu, Phelps & Stotsky (2013) looked at the bonds in Africa, with the same aim of researching determinants. Despite major differences between the Asian and African regions, the findings were surprisingly similar. This paper found that English legal origin, good institutions, and stable exchange rates were factors that contributed to the growth of bond markets. However, while Eichengreen & Luengnarumitchai (2004) maintained that in their study fiscal balances were mostly a non-factor, Mu, Phelps & Stotsky (2013) found it to have a statistically significant negative correlation with the bond market development.

Contrary to the regional approach of these two studies, Smaoui, Grandes & Akindele (2017) decided to select emerging countries from Africa, Asia, Latin America, and Eastern Europe. And what they found was that the size of GDP, quality of institutions, macroeconomic variables, and factors, among others, were identified as positive determinants, while government budget balances for example were identified as negative determinants.

These three studies all aimed to identify determinants of bond market development, two of them targeted specific regions whereas the third focused on emerging and developing nations from multiple regions of the world. Nevertheless, the findings of these three papers were incredibly close to one another. They spoke of the same factors, both the positively correlated ones and the negatively correlated ones, came to the same conclusions, and offered similar policy suggestions. While the reasoning for similar variables being included in the study to begin with has to do with the fact that a lot of research on this topic within academia is based on Eichengreen & Luengnarumitchai (2004), the fact that empirical analysis done by other researchers yields similar results indicates that it is permissible to accept those views.

Eichengreen, Borensztein & Panizza (2006) also looked into the differences between two rising and growing bond market regions of the time, specifically East Asia and Latin America. This research was warranted by the fact that both of the regions were underperforming compared to the theoretical expectations but for completely different reasons. Asian markets were found to be more robust, capitalized, and characterized with notable investor protections, whereas Latin American region was undoubtedly more liquid by any measure than the East Asian one. The difference was explained by a number of factors. East Asia has had a much more unified approach to developing their sovereign and private bonds, with nations aiming to integrate the markets, which is what led to the advantages they had. But at the same time, the profile of their investors consisted of pensions funds way more frequently than it did in Latin America, proving that retail investors were shying away from East Asian markets. This paper is of great importance when it comes to displaying the full relevance and level of impact institutions and institutional regulations have on formation, development, and composition of the bond markets, especially the younger ones that are in need of growth to be viewed seriously.

Asian bond markets have been an exceptional focus of study for two main reasons, those being their surprising underperformance and also the 1997 Asian financial crisis, which severely hurt the bond ratings of many nations at the time. Not unlike the other papers, Bhattacharyay (2013) is also highly influenced by Eichengreen & Luengnarumitchai (2004). Nevertheless, while papers such as Mu, Phelps & Stotsky (2013) and Smaoui, Grandes & Akindele (2017) seemingly tried to replicate the findings in different regions and based their own models and choices of variables after that study, Bhattacharyay puts in more effort in order to discover the determinants themselves and not rely completely on the findings of others. In total, Bhattacharyay (2013) found five major determinants of bond market development in Asian markets, which are summarized in Table 3. This result highly contrasts

with Eichengreen & Luengnarumitchai (2004) who had a total of 15 major determinants outlined as significant enough. The other findings of the paper were that Asian bond markets, be they government bonds or corporate bonds, were severely undercapitalized. This was explained in a two-step process, the corporate bonds could not develop in an economy where government bonds were not developed, and government bonds lacked the necessary regulatory framework to attract a sufficient investor base.

Table 3.

Findings of Bhattacharyay (2013)

Major Determinant	Variable used	Relationship direction
Size of the economy	GDP PPP	Positive with all bond types
Development of the economy	GDP PPP Per Capita	Positive with all bond types
Openness of the economy	Exports-to-GDP ratio	Positive with corporate bond
Scale of the banking system	Domestic credit-to-GDP ratio	Positive with all bond types
Interest rate spread	Lending rate – deposit rate	Negative with all bond types

Source: compiled by author on the basis of Bhattacharyay (2013)

Pradhan, Arvin, Bennett, Nair & Hall (2016) and Pradhan, Arvin, Norman & Bahmani (2018) both analyse the same segments and variables and arrive at more or less the same conclusions, which should not be surprising as the latter is basically the authors revisiting the topic and delving a bit deeper than before. These studies focused heavily on the cointegration of several major variables within the economic growth rate and came to the conclusion that, especially in the long run, equity returns, and bond market development are heavily cointegrated with the economic growth, and when it comes to the question of causality, it also says that bond market development is the one affecting economic development, not the other way around. However, this was found to be true only in the long run, whereas in the short run the Granger causality tests are not as clear and indicate a much more dynamic and intense relationship between all the involved variables. In this manner, these two papers support bond development causing the economic growth, but only to a point as in the short run different models all detected a level of bidirectional causality between bond markets and economic growth. While this may seemingly further complicate the topic at hand and add new nuance that needs to be considered, the focus is on long-term bonds and their effects, for which reason this paper can be interpreted as supportive of the claim made by Fink, Haiss & Hristoforova (2003) in that with regards to causality question, it is the bond development which causes the economic one.

Fanta (2017) studied the relationship between growth and financial capitalisation, specifically equity market, banks, and most importantly bond market, thus standing out from many other papers that exclude bonds from this topic. The specific topic here was capitalisation, which differs little from bond market development. Whereas development tracks the change in bond market size, capitalisation represents the size at the time period. The division between these two variables can be compared to GDP and GDP growth. In other words, while using a somewhat different variable this study is very relevant to this paper's topic. The results of Fanta (2017) where somewhat surprising since it found that bond market capitalisation was the only variable among those examined to have a strong and a positive causal impact on economic growth. Equity capitalisation and bank credit was found to actually have a negative impact, mirroring the findings of Ritter (2012) mentioned much earlier in this paper, although this impact was not statistically significant. Yet another caveat to be mentioned with regards to this study is that it did not exclude private debts, i.e., corporate bonds from the total bond market data, nor did they offer a composition breakdown of the selected dataset.

Nevertheless, the findings of that paper should not be dismissed easily. Not only do they fall in line with the previously discussed literature, but they are also backed by papers discussing the same variables in other regions, such as the one by Nguyen and Nguyen (2019) examining Asia. This paper was remarkably similar to that of Fanta (2017) in its methodology, and more importantly in its choice to examine stock and bond market capitalisations as well as the role of banks. What Nguyen and Nguyen (2019) did better, however, is that they split the analysis on debt along the public and private, as well as domestic and international lines. This allowes for closer examination of the relationship, and proper observance of government bond market in the equation. Their conclusion was that bond markets had a positive impact on economic growth and were far more notable than the other variables examined. Furthermore, they specified that both publicly and privately owned debts, when separated, retained the positive relationship with economic growth. Albeit when specified to international public debt, this effect was not statistically significant, in juxtaposition with the domestically held government bonds.

Country-specific studies tend to be even more split on the issue, which should be of no surprise as they are fully affected by the idiosyncrasies of the nation they are examining, since those effects are mellowed when analysing a panel of different economies Kapingura and Makhetha-Kosi (2014) focusing on South Africa found a bidirectional causality, but they did note that the supply-leading relationship was stronger and more evident.

The summary of the bond market interactions is quite similar to that of the public debt, which further justifies the discussion around it earlier in the paper. While the existence of its relationship with the economic growth cannot be denied, and for the most part the direction of this relationship is agreed to be a positive one, authors are somewhat split on the causality issue between bond market development and economic growth, not unlike what was observed in the literature surrounding sovereign debt. However, this time around, there is at least a clear trend of supply-side arguments dominating the discourse and having more supporters, whereas when generalized to debt the causality becomes a much bigger blur.

1.3. Yield curve and its relationship with the economic growth rate

Previous studies have so far not fully covered the research gap that is the relationship between bond market and economic growth, but for years now certain trends have been assumed to be true. For example, while there is no strict interpretation for strength of the relationship, yield curve is assumed to be predicting the economic growth. Yield curve showcases the yield rates for bonds of different maturities, generally it is assumed that the longer a bond's maturity the higher its yield should be. High yield spreads, that is the difference between yields at different maturities, are said to signal strong economic growth. Lower the yield spread gets, less optimism is there in the market for strong growth, and scenarios where yield curve inverts and short-term bonds have higher yields are interpreted as investors having bad expectations for the economy, as was witnessed in 2020 following the fears of COVID-19 impact on the economy (Ranasinghe & Rao, 2020).

Fink, Haiss & Hristoforova (2003) in their paper's empirical review report that the impact of changes in the yield curve spread and slope is indeed an effective explanatory variable for economic growth, sometimes even more effective than the returns of stock market. However, their findings also show that once Federal Reserve Bank gets involved and introduces policies directly aimed at combatting the negative variables such as inflation levels that are too high, yield curves stop being a tool for predicting the economic growth rates, meaning that their validity is not certain at all times. While the results of their own empirical research did not give fully consistent outputs for each country they examined, all the samples fell into two groups with most of them showing signs that bond market caused changes to economic activity, i.e., supply-leading causality, and a minority of the tested countries showed interdependence between these two variables, thus summarizing that changes in bond market strongly affect changes in economic output. What is interesting is that not a single country showed evidence for having a demand-leading relationship, i.e., economic growth being the factor that has causality over the bond markets.

While the paper was written with due diligence and many factors were taken into account with proper econometric methods, some of the outputs are disputed by other authors. Thumrongvit, Kim & Pyun (2013) examine a lot of literature on their own, including the previously discussed study, and report that one cannot be too sure about which side of causality each variable is on, when it comes to the relationship between bond market data and economic growth rate, as many different papers give different answers. Among their findings, they also talk about how the impact of government and corporate bond markets on economic growth rate are complete opposites, with government bond markets having a positive relationship and corporate one having a negative relationship. When compared to the surprising results about how stock returns had little and negative impact on growth rates (Ritter, 2012) this yet again shows that corporate bonds oft share a certain degree of similarity with equity markets, as mentioned before, something that rarely happens with government bonds. A noteworthy part of this paper is that not only does it talk about causality as measured by the models, but it tries to explain exactly where bond market effects fit within the greater financial model, with their suggestion being that presence of bond markets ensure banks do not become overcapitalized which in turns helps avoid a series of wasteful decisions from banks and other financial institutions. It would seem that this paper yet again contradicts with the previously discussed study, because Fink, Haiss & Hristoforova (2003) reiterate the position held by many neoclassical economists that there is no causal link between financial institutions and real economic output, even if a correlation may be detected.

While not explicitly aiming to study the differences between causalities, a paper about Bangladeshi situation offers an interesting insight into this question. The topic of the paper was to discuss the potential benefits and outcomes of strengthening and broadening the bond market in Bangladesh, and to do that economies of four other Asian, but otherwise quite different, nations were examined. Specifically, the relationship between 10-year bond yields and economic growth was analysed in Indonesia, Japan, Hong Kong, and India by Rahman, Nower, Abbas, Nahian, & Tushar (2020). The reason why this study is noteworthy is that of the four nations examined, all four yielded different results in response to the Granger causality test, which is by far the most prominent causality test employed in all the papers discussed in this thesis so far. India was noted to have a bidirectional causality, Indonesian data suggested a supply-leading unidirectional causality whereas for Japan it seemed that the causality was instead demand-leading, as in it was the economic growth that affected the bond yields. And finally, no significant causality was detected, for Hong Kong.

There are many more studies that work to link economic growth to yield in one way or another. Chinn and Kucko (2015) looked into the oft asked question of how well do the yield spreads and yield curves forecast economic growth. They used a panel of data with time series period going from 1970 to 2013. A short summary of their findings is that yield spreads do in fact forecast both growth and recession, however looking deeper into the trends revealed other details. Namely, the apparent re-emergence of yield spreads forecasting powers. According to this study, the predictive power kept declining year over year up to the Great Recession, but ever since 2008 the yield spread data seems to have rebounded in a way and is now forecasting economic growth over a one-year horizon with surprising predictive power. Interestingly enough, no other study about yield spread's forecasting power that is discussed in this thesis reveals a similar trend. The other studies, focusing on different variables and data, have also for the most part found that post-2008 relationships have not changed too much.

Another paper to be considered is Matei (2014), which examined bond market and economy of 26 EU nations for a ten-year period, specifically 2002-2012, and concluded that there does exist a relationship between yield curve and economic growth, but the relationship is not the same across the board. Specifically, the study claimed that the relationship between GDP growth and yield curve slope is positive for Euro area countries, ones which are also identified as higher income nations, and negative for the remaining Emerging Europe countries.

This paper is valuable for two reasons – first, it provides further proof to establish an existing relationship between bond market and economic growth. Second, it demonstrates that the effect a variable has on the economic growth rate can be completely different based on if the country is wealthy to begin with, or not. This is reminiscent of other similar scenarios, for example income inequality, which has been shown to only be positively correlated with higher economic growth in states whose citizens can be considered as high earners (Shin, 2012). So, this discovery that yield curve slopes correlate in different directions based on prosperity of the nation does not in any way cast shadow on the validity of the statement, if anything this shared trait of yield curve slopes and inequality indexes poses to be an interesting research question of its own.

In another study, Matei decided to conduct not a country-specific study, but rather a country-by-country analysis of 16 Euro Area nations. While the analysis per country is not as thorough as they are in country-specific studies, it is nevertheless a very valuable paper since it offers data on several nations at once without using a panel approach. Thus, all the results

are fully affected by the underlying mechanisms inherent to each different nation. The results were that four of the countries had supply-leading causality, one had demand-leading, and one had a bidirectional causality. As for the rest of the examined countries, no statistically significant result was obtained. (Matei 2012)

While not about yield curves themselves but rather about long-term yield rates specifically, a rarely examined variable which makes this a very valuable piece of literature for this thesis, a paper by Afonso & Nunes (2014) contributed to the literature by examining the relationship between economic growth forecasts and changes in yield rates and yield spread. Specifically, their study found that forecasts would impact bond yields, with the effect being generally higher in countries that had low government credibility and significant amount of government debt. However, it should be noted that the paper made some heavy initial assumptions about the direction of causality between economic growth forecasts and bond yield statistics, without much theoretical background.

Going back to the papers discussed in this review, such as the ones by Pradhan, Arvin, Bennett, Nair & Hall (2016), Pradhan, Arvin, Norman & Bahmani (2018), Fanta (2017), and Thumrongvit, Kim & Pyun (2013) for example, one can see the general consensus that a relationship between bond markets and growth of economy exist. But these papers also underline the fact that the nature of the relationship is not very well studies, which is exactly the gap that this research paper aims to fill. Analysing these papers together shows that there are disputes about causality, with opinions being quite split but somewhat in favour of the sentiment that it is the bond markets that influence the growth rate. The strength of the relationship also varies study by study, and some even suggest that the very direction of it is not set in stone. Furthermore, there is very little focus on the bond yields themselves. The little research that tries to tackle that specific issue is somewhat shallow and looks at small, specific questions only.

In conclusion, this paper has examined more than enough authors and articles to show that the overall literature is full of disagreements and wildly different results on the same topics, often seemingly due to sample choices, with the only trend being uncertainty about specific relationships. This can be addressed by approaching the research carefully and double guessing oneself at every step, so as to avoid falling into the trap of assumptions.

2. Empirical analysis

2.1 Data and methodology

To conduct the proper empirical research, four economic variables were chosen. Two of them are stand-in variables for the long-term government bond yields and economic

growth, the main points of discussion of this paper. The with the data spans for 25 years between 1995 and 2019 and the panel consists of 15 developed nations, specifically Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom, and United States. The limits of data availability were a significant factor for this study, and specific obstacles will be discussed for each variable.

Yield data will be represented with the annual yield rate for 10-Year government bonds. Bond yields are not a major macroeconomic variable like GDP for example, and for that reason its historical data is not tracked with as much diligence. Instead, bonds are a market-tradeable security which means that their yields slightly, but constantly, fluctuate on a daily basis. While some databases list daily records, many maintain archives only for monthly, quarterly, and even yearly datapoints.

The reason why this is relevant is that the way those datapoints are converted into yearly ones often differ, meaning that different databases may give somewhat different numbers. At the same time, relying on a single database is inconvenient, as it may give a great amount of data for select few countries but heavily lack in others. The only way to have extensive amounts of historical data for a good number of nations is to consult several databases. Table 4 shows the differences found among different databases, which differ due to different methodologies employed by their compilers, and thus displays why diligence must be employed.

Table 4

US 10-year bond yield historical data in 2001-2010; Comparison

Year	OECD Data	Clio Infra Data	Difference
2001	5.09	5.02	0.07
2002	4.03	4.61	-0.58
2003	4.27	4.02	0.26
2004	4.23	4.27	-0.04
2005	4.47	4.29	0.18
2006	4.56	4.79	-0.23
2007	4.10	4.63	-0.53
2008	2.42	3.67	-1.25
2009	3.59	3.26	0.33
2010	3.29	3.21	0.08

Source: compiled by author on the basis of OECD (2021), Verriet & Bosch (2012).

From the table one can see that differences between databases can sometimes be quite stark, like in 2008. The differences stem from the fact that when periodizing daily yield data, different sources use different methods. For example, some may calculate a higher period by calculating the simple average of the smaller provided periods, which is the preferred method

by OECD and how the data is presented by default in their datasets, whereas other sources – in this case Clio Infra Database – go with the so called "End Of" method, in which the value of the latest entry in the period is chosen to be the value of the entire greater period itself. Unfortunately, no single dataset on bond yields is complete to such an extent that they allow to complete an analysis without complementary sources. However, it should be noted that OECD is not merely a data repository but an influential and relevant international organisation. Their preference for "Average of" methodology, combined with the basic argument that perhaps data from a single month should not decide yearly data, acts as this thesis' argument and justification for why "Average of" data is used in every entry that it was possible. However, certain entries had to be filled from Clio Infra, whose data slightly differs.

It should also be noted that historical data for bond yields do not exist for many nations. For example, during the 1980s, the Latin countries were unable to organize bond markets themselves, to such an extent that in 1989 the US organized a "Brady Plan" to help the nations manage their sovereign debts. The effects of "Brady Plan" were not immediate, so the 90s was still a volatile time economically in the region, and bond markets really started developing and growing after the onset of 21st century (Chen, 2019). In Europe, countries formerly in the Eastern Bloc did not have bond or financial markets in the same vein that they have existed in the west for a long time. While throughout 90s the communist governments were no longer in charge, it took some time for nations to get transition to market economies and start issuing bonds, so the data for these countries also only begins to be noticeable from 2000s and onwards. Some nations, like Estonia which has issued bonds only 3 times since regaining its independence (Rahandusministerium, 2021), opted to issue bonds only when absolutely necessary, thus no historical data can be observed for them. And with regards to Asian and African continents, the theoretical chapter explained how those regions struggle with developing bond markets at a steady rate due to its complex determinants and difficulties to alter or affect those determinants. These factors severely limited the amount of viable countries that could be examined.

As for the economic growth, it will be measured using % Growth in GDP Per Capita. Foley (2012) argues that economic growth is a two-sided phenomenon, in which on one hand you have growth of earnings and expenses, and on the other hand you have growth of the scope of production. The most common metric used to measure that is GDP, which is the total monetary value of all the goods that have been produced within a nation as well as all the services that have been provided (Kramer, 2020). While the explanation of Foley (2012) goes more in-depth, GDP does correspond to most of the concerns raised by him. It must be

noted also that there are no attractive alternatives. GNP, which GNP is the total value of products and services provided by the nation's residents and companies even if they are abroad (Amadeo, 2020a), was used in the past but has since been abandoned as GDP better represents the actual activities within the nation.Gross National Income, which calculates income instead of total productivity of individuals and business (Amadeo, 2020b), is an interesting concept, but no serious arguments have been made why it should replace GDP. The only example is Ireland, which due to its unique position in the global market has a highly skewed GDP growth rate, something that Irish policymakers themselves admit (Boland, 2017). Since Ireland is part of the sample, its % growth in modified GNI per capita variable was calculated for the period starting from 2015, since that is when GDP started to become skewed and diverge heavily from GNI calculations (CSO Ireland, 2020).

The GDP data is not being adjusted for factors such as PPP and inflation. The thesis takes into account the population change and the impact that population growth alone may have on overall economic growth by using per capita variable. However, since all of this is supposed to be compared to yield data, adjustments for factors like inflation would be a mistake. Bond yields, at the end of the day, are basically interest rates on debt that government has taken on. Since all the yield records are based simply on the market data it means that they are nominal interest rates. Conducting analyses between nominal interest rates and real GDP per capita growth rates would show inaccurate findings, so the datasets were left in nominal state for better results.

The next variable is debt-to-GDP growth. The literature that was examined in the theoretical part of this paper uncovered plenty of evidence to suggest that this ratio variable has a statistically significant relationship with the economic growth. The data, like the yield rates, came from the same source. Inclusion of this variable was also highly limiting, as pre-1995 data is very inconsistent and lacking for even the developed and relevant economies. The main arguments for including this variable were testing the literature findings empirically, which would be beneficial for the overall conclusive discussion at the end of the paper, but also to examine the relationship between bond yields and debt-to-GDP ratio. Not only would such relationship contribute to the literature, but it could also provide proof of indirect relationship between bond yields and economic growth in case a direct relationship was not found.

The last variable included in this study is Gini coefficient, which is a measure of income inequality. In the theoretical part a lot of sources were discussed that showed different level of impact based on the nation's wealth. Such nonlinearities and differences are

not too uncommon, but there were also noteworthy findings of the very direction of the relationship changing when yield curves were examined. This level of difference being caused by national wealth on a relationship between two variables is far more uncommon, although the one topic where it is frequently found is income inequality. In poorer nations, economic growth is generally found to be correlated with reduction of inequality. But in richer countries, their relationship is positive. Due to these similarities between yield curve variable and income inequality, the Gini coefficient was added to the thesis to see if these two had a noticeable relationship.

The data collection for this coefficient proved to be the most difficult as even WorldBank did not keep track of yearly Gini coefficient levels for most nations up until very recently. Similar to the yield data, no single database was extensive enough to have been enough on their own. For this reason, a great number of Gini databases had to be consulted, including a source that compiled and stored all the different calculations used for each country. As a result, the data for Gini coefficients are not all calculated with the exact same formula and exact same inputs.

Table 5 displays all of the stand-in variables as well as sources consulted by this thesis when attempting to construct a database for each of them.

Table 5

Data and variables

Data	Stand-in variable	Sources
Long-term government bond yield	10-Year bond yield rates, Annual	Verriet & Bosch (2012) OECD (2021) Eurostat (2021)
Economic growth	% Growth in GDP Per Capita, Annual % Growth in GNI Per Capita, Annual, Ireland 2015-2019	WorldBank, (2021) CSO Ireland (2020)
Debt to GDP ratio	General government debt-to-GDP as %, Annual	OECD, (2021)
Income Inequality	Gini Coefficient, Annual	WorldBank (2021) OECD (2021) Eurostat (2021) Milanovic (2019)

Source: compiled by author.

As for the methodology, it was highly affected by the dataset itself. The initial plan was to construct a linear regression model along with other tests to test the relationships and their strengths and directions. However, due to a highly non-parametric dataset, linear

methods could not be utilized. As a part of testing the data, certain data transformation methods were applied such as indexing and log-linearisation, but this path did not yield any tangible results. Plus, with so much theoretical background showing non-linearity between bond-related variables and growth, forcing a linear fit would cast doubts on the validity of the model. Instead, data was analysed with correlations and partial correlations to investigate the strength of trends, and Panel Granger causality test was employed to investigate the causal direction as that has been a topic of contention in literature.

2.2 Descriptive analysis and assumptions testing

Before inferential analysis is conducted, descriptive analysis is performed to explain the basic features of the dataset. Table 6 presents descriptive statistics for the four variables.

Table 6

Descriptive Statistics

	N	Median	Mean	Std. Dev.	CV	Min	Max	Skewness	Kurtosis
10-Year Yield Rate	375	4.13	3.89	2.16	0.56	-0.25	12.21	0.47	0.91
% Growth in GDP Per capita	375	1.64	1.58	2.27	1.44	-8.51	9.80	-0.44	3.29
Gini Coefficient	375	28.8	29.49	4.79	0.16	20	41.5	0.66	0.08
Debt-to-GDP ratio	375	72.1	78.79	31.00	0.39	27.5	156.9	0.53	-0.74
Valid N (listwise)	375								

Source: Author's calculations

The panel data has an entry in all variables for each of the 15 countries, fully covering the 1995-2019 period range, which means that the constructed dataset is strongly balanced. The mean and the median values are quite close for all variables, which tells us that distribution should not skewed too badly. However, it is also notable that for the yield variable both mean, and median are much closer to the minimum value than they are to the maximum value, so distribution cannot be perfectly normal either.

On the other hand, relationship between mean and standard deviation is quite different across the board. Debt-to-GDP ratio has a high range and high values for mean and median but nevertheless, a standard deviation of 31 points can be considered as somewhat high. By calculating the coefficient of variation, one can also see that GDP growth is quite spread around its mean, but the other variables still have a CV value of below 1, indicating a low variance – especially the Gini coefficient.

Figure 1 shows histograms for the four variables. The skewness from the descriptive statistics table is close to 0 for all variables, which would imply that they are all quite symmetrical. However, examining them visually shows that only % Change in GDP Per Capita variable is actually symmetric when plotted. On the other hand, that variable has a kurtosis value of 3.29 and the histogram itself showcases just how strongly peaked it is.

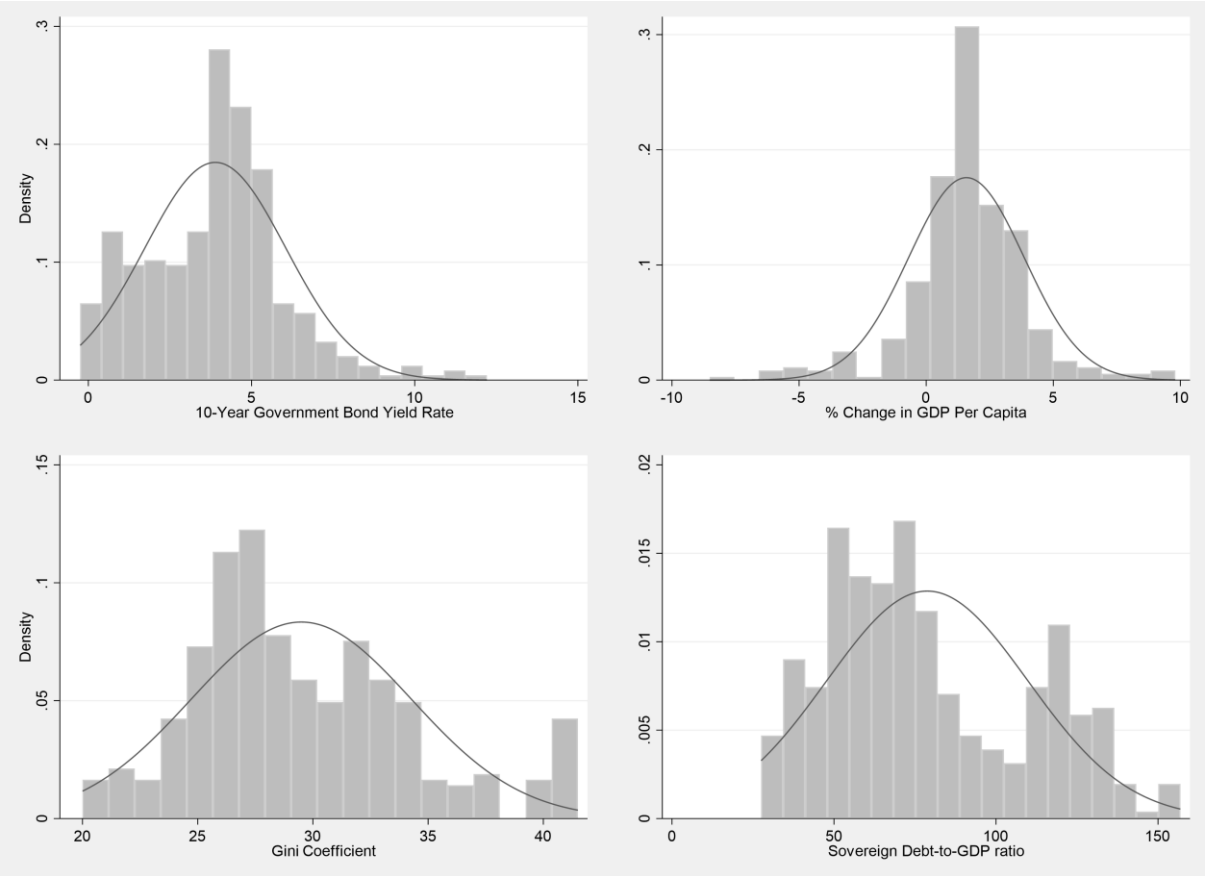


Figure 1. Histograms of variables

Source: Author's calculations

Gini coefficient, and to a greater extent 10-year yield rate, graphs showcase that the data for those variables is distributed in a right-skewed way. As for the debt-to-GDP ratio, it is very clearly bimodal with one peak being around 50-70% range, and the second at 120% range.

So far, the descriptive statistics and the histogram visualisations all indicate that none of the variables are distributed normally. This is further confirmed by running a Shapiro-Wilk test, results for which are provided in Table 7. The p-values for all four variables were 0, meaning that null hypothesis of normal distribution must be rejected and H_1 hypothesis of non-normal distribution for all variables, at 1% significance level, will be accepted.

Table 7

Shapiro-Wilk normal distribution test

Variable	Obs	W	V	z	Prob>z
10-Year Yield Rate	375	0.9639	9.381	5.311	0
% Growth in GDP Per capita	375	0.93232	17.587	6.802	0
Gini Coefficient	375	0.95651	11.3	5.752	0
Debt-to-GDP ratio	375	0.94515	14.252	6.303	0

Source: Author's calculations

A further characteristic of the data to be checked is linearity. Figure 2 shows the scatterplot for 10-year yield rate and % Change in GDP Per Capita, the main two variables of the thesis. Additionally, a scatterplot matrix that observes relations between all the variables can be seen in Appendix A.

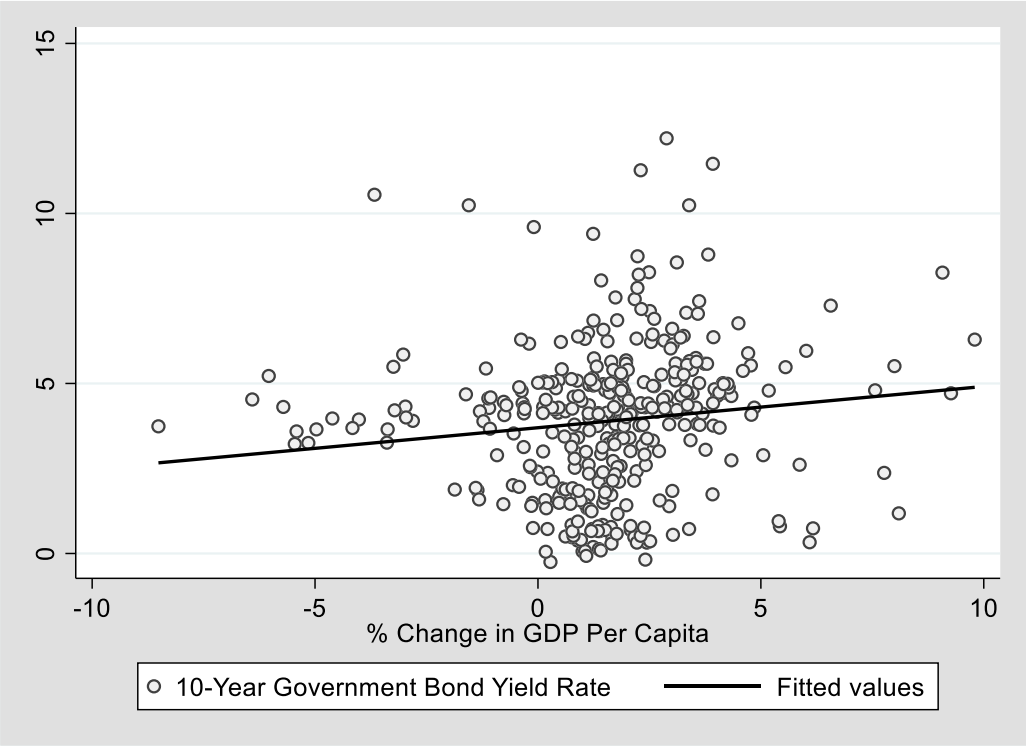


Figure 2. Scatterplot of 10-year bond yields and % change in GDP per capita

Source: Author's calculations

The scatterplot graph shows that the relationship between these two variables is very non-linear. There are noticeable outliers, and the pattern of observations resembles neither an upwards-trending line nor a downwards-trending one. The relationship between these two variables was the most important one – if it had been linear then regression could still be built, simply without some of the other variables. Or even a completely different dataset could be built. However, Figure 2 showcases that linear regression with this dataset is simply not a rational approach. Scatterplot matrix in Appendix A also shows that all the relationships between four variables are similarly non-linear.

The final assumption that needs to be checked is stationarity of data, with the use of unit-root tests. Stationarity is an assumption of Granger causality test, and since the aim is to examine causality precisely with that method, its assumption has to be met. Table 8 showcases results of four different unit-root tests for all variables. Furthermore, Table 9 reports the results of Fisher-type unit-root test, which itself has 4 measures of p-value.

Table 8

Results of unit-root tests

Variable	Levin-Lin-Chu	Harris-Tzavalis	Breitung	Im-Pesaran-Shin
10-Year Yield Rate	0.0902*	0.1675	1	0.0827*
% Growth in GDP Per capita	0***	0***	0***	0***
Gini Coefficient	0.0055***	0***	0.355	0.0282**
Debt-to-GDP ratio	0.1151	0.9942	0.9586	0.9971

Notes. *** - significance at .01 level; ** - significance at .05 level, * - significance at .1 level

Source: Author's calculations

Table 9

Fisher-type unit-root test p-values

Variable	Inverse chi-squared	Inverse normal	Inverse logit	Modified inv. chi-squared
10-Year Yield Rate	0.0145**	0.097*	0.0430**	0.0062*
% Growth in GDP Per capita	0.000***	0.000***	0.000***	0.000***
Gini Coefficient	0.0504*	0.0202**	0.0294**	0.0381**
Debt-to-GDP ratio	0.9952	0.9978	0.9971	0.9823

Notes. *** - significance at .01 level; ** - significance at .05 level, * - significance at .1 level

Source: Author's calculations

For debt-to-GDP ratio variable, there is no option but to accept the null hypothesis of unit root, thus making the data non-stationary. On the other hand, % growth in GDP per capita is most assuredly a stationary dataset by all metrics. Gini coefficient has a single result in Table 8 suggesting it has unit root but looking at the other results it is safe to assume that Gini is stationary as well. The four different statistics of Fisher-type unit-root test in Table 9 mirror the findings from these results. There as well, GDP growth is shown to be stationary and debt-to-GDP is shown to have a unit root. For Gini statistic all the results in Appendix 2 indicate stationarity but not necessarily at .05 confidence level.

The variable with somewhat questionable stationarity is 10-year yield rate. Two tests attest to its non-stationarity, two tests completely reject that hypothesis and instead display stationarity at .1 significance level. But combined with the fact that Table 9 shows it to be

stationary as well across all its tests, it is safe to say that the only non-stationary variable in this dataset is Debt-to-GDP ratio. With these findings recorded, the next step is to engage in empirical research.

2.3 Empirical analysis

To begin empirically researching the relationship between the variables, specifically between the 10-year yield rates and % growth in GDP per capita, first of all the correlations tests will be used. Pearson correlation is generally preferred when applicable. But in this scenario, it is completely out of question due to its assumption of normal distribution as well as linearity between the examined variables, which the dataset of this thesis violates. Instead, Kendall's Tau and Spearman's Rho correlation tests were both conducted, and the results are presented in Appendix B. In terms of statistical significance and direction of correlation, the results between two tests matched. Between the 10-year yield rates, % growth in GDP per capita, and debt-to-GDP ratio, all pairs had a statistically significant correlation at a .01 level. As for the Gini coefficient, it only had a statistically significant correlation with debt-to-GDP ratio, also at .01 level. All correlations were at .3 level or below, except for Gini and debt-to-GDP as examined by Spearman's rho. Kendall's tau values were much lower, which is generally the case between these two correlation tests. Overall, it can be interpreted that all the correlations found in this paper are weak, even if statistically significant.

Since debt-to-GDP variable was shown to correlate with both the yield rate variable and GDP growth variable, partial correlation test was run between yield rate and GDP growth that controlled for debt-to-GDP. Since this is a non-parametric data, the approach was to conduct non-parametric Spearman correlation, recode it into Pearson correlations and run a partial correlation afterwards. The result of this partial correlation is presented in Table 10. Correlation is positive and weak but significant at .01 leve1. While the methodology is not very common, it relies on the fact that Spearman correlations are Pearson correlations of two ranked variables, and similarly Spearman partial correlation can be interpreted as Pearson partial correlation of the residuals obtained when ranks of the correlated variables are linearly regressed on the ranks of the control variables (Liu, Li, Wanga & Shepherd, 2018).

Table 10

Partial correlation result

Control	Variables		% Growth in GDP Per capita
Debt-to-GDP ratio	10-Year Yield Rate	Correlation	0.229
		Significance (2-tailed)	.000**
		df	372

Source: Author's calculations

It is interesting to note how these findings relate to the theoretical findings obtained earlier in the thesis and other literature pieces, both their similarities and differences. In terms of their direction, they aligned with the literature findings as well as basic expectations one may have based on macroeconomic theory. Debt-to-GDP ratio had a negative relationship with the % growth in GDP per capita. This mirrored the findings of several authors discussed previously in the paper that also found the relationship between these two variables to be negative, although this thesis did not look into differences based on the development of the country, which in some cases negated the effect altogether (Caner, Grennes, & Koehler-Geib, 2010; Calderon & Fuentes, 2012; Kumar & Woo, 2012; Sadik-Zada & Gato, 2019; Gargouri & Ksantini; 2016).

Another variable that debt-to-GDP ratio had a correlation with was the Gini coefficient, which measures national inequality. What this means is that higher levels of debt-to-GDP ratio are associated with higher levels of inequality in the nation. Similar relationship was found by Azzimonti, de Francisco, & Vincenzo Quadrini (2014) who analysed the links between the three trends of modern world – rising inequality, rising public debts, and globalization of finances and financial markets. They found that rise in income inequality may cause income risks, or that those risks may even appear independently and be worsened by inequality. This additional risk motivates the governments to take on more debt, which would be one explanation for the correlation between the variables. Another explanation they offered was that globalized financial markets may be what causes the growth in sovereign debt, especially seeing how bonds from the United States are being bought by foreign governments more and more frequently, and this leads to reduction of global interest rate. And with the lower interest rate, governments become even more willing to take on a new debt, creating a cycle of sorts.

Borissov and Kalk (2020), who studied the effect of public debt on wealth inequality, demonstrated a similar correlation, although from a different approach. Their analysis suggested that at low debt-to-GDP ratios, wealth inequality will consistently reduce over time until the economy reaches the point of an equilibrium and perfect equality. However, they also discovered the existence of a threshold in debt-to-GDP ratio, above which the excess debt causes the society to diverge into two, with one part becoming poorer and poorer, and the other growing in wealth and capitalisation.

Debt-to-GDP ratio also correlated with 10-Year bond yields. With the two other correlations being backed up by literature, it is not a stretch to suggest that perhaps this

correlation is also one grounded in reality. However, the correlation in this situation is negative, which means that higher levels of debt-to-GDP are associated with lower levels of 10-year yield rates, which can also be called interest rates on government debt. Baldacci and Kumar (2016), whose paper was discussed in the theoretical part, found that an increase in deficit caused a heavy increase in interest rates. The difference between this paper's result and that of Baldacci and Kumar (2016) may be caused by the dataset and approach, specifically they found this positive correlation to be true in the long run. The time period analysed in this thesis is not too short, but it is not a particularly lengthy time series either.

Another surprise was the lack of correlation between Gini and GDP per capita growth. Shin (2012) and its findings, specifically that economic growth and income inequality are highly correlated but in different directions based on national wealth, was discussed earlier in the paper. Rodriguez (2000) offered a similar interpretation of the relationship, and the general statement of correlation between those two variables is also confirmed by many other studies. For example, Ncube, Anyanwu, & Hausken (2014) examined the region of Middle East and North Africa and found a causal relationship. Their statement was that income inequality had a reductive power on economic growth. Either way, they still confirmed the correlation between the two, something this paper did not.

With the correlation tests analysed, the next step is to employ the Granger causality test. The correlations had to be consulted because the choice was made to enter the topic with as few assumptions as possible, and the research aim was to flesh out the relationship between variables. Thus, empirical analysis had to begin with the basics, and correlation analysis establishes one of the most basic relationships possible. And with causality being the debated topic in literature with very little consensus, the logical next step was to focus exactly on that and try to contribute to the existing discourse with a new paper.

The specific test that is used is called panel Granger causality test, which performs exactly as normal Granger causality test would but is slightly adjusted to give better results when dealing with panel data. Since debt-to-GDP variable was shown to be non-stationary and thus violate the assumption of Granger test, it is not included, but all other relationships are examined. Table 11 offers the overview of causality results between the remaining three variables.

Table 11

Granger causality results

Null Hypothesis	p-value

Gini coefficient does not Granger cause % growth in GDP Per Capita	0.6918	Accept
Gini coefficient does not Granger cause 10-year yield	0.1053	Accept
% Growth in GDP per capita does not Granger cause 10-year yield rate	0.9508	Accept
% Growth in GDP per capita does not Granger cause Gini coefficient	0.4803	Accept
10-Year yield rate does not Granger cause Gini coefficient	0.1609	Accept
10-Year yield rate does not Granger cause % growth in GDP per capita	0.06543*	Reject

Note. * - significance at .1 level

Source: Author's calculations

The null hypothesis of Granger test is that the independent variable does not Granger cause the dependent variable, which basically means that the changes in independent variable precede very similar changes in the dependent variable by a constant amount of time over a long period.

This thesis analysed Granger causality between all three pairings of variables, in both directions possible. The p-values show that there is no Granger-causal relationship between them, with the exception of 10-Year yield rate and % growth in GDP per capita. In that case, 10-year yield rate is shown to Granger cause % growth in GDP per capita, albeit only at a .1 significance level.

Relating these findings to the literature overview is a bit more challenging than it was with the correlation results. As it was mentioned several times in the theoretical part, the articles and academic papers are very split on the causality issue, and not simply in two camps either. For example, looking at the bond-related literature we can see that Rahman, Nower, Abbas, Nahian, & Tushar (2020) as well as Fink, Haiss & Hristoforova (2003) Found a supply-leading causality, i.e., the bond-related variable was the causal one, not the growth variable. While Kapingura and Makhetha-Kosi (2014) did admit that supply-leading causality was the stronger one, their results showcased a bidirectional causality. And Matei (2012), who actually analysed 10-year government bond yield rates and yield slopes in 16 countries, found one bidirectional, one demand-leading, and four supply-leading causalities. Overall, it can be interpreted as the findings of this thesis aligning with the majority of existing literature.

Conclusion

Rate of economic growth is a major variable that is often studied. It determines how quickly can the nation progress its economy, reach new levels of prosperity, and increase its quality of life. For these reasons, it is not uncommon for economic growth and rate of

economic growth to be studied by economists. Among the many variables that it is often compared against, such as stock market returns, income inequality, and others, bond markets and especially bond yields are rarely included. The thesis aimed at tackling this huge gap in the literature and determining the nature of relationship between long-term government bond yields and economic growth rate. In its theoretical part, it provided huge amounts of background information regarding bonds, bond markets, public debt, and how they relate to economic growth as a way to lay foundations for yield discussion. Articles that were reviewed have considered many nations across all regions of earth, and decades of time periods. It found that bond-derived or bond-related variables were often correlated with economic growth rate, with some consistency, but also a great deal of variation in results. One trend has been that of supply-leading causality, meaning that this thesis discovered most articles view market-related variables to be the ones affecting the economic growth rate, not the other way around. In terms of directions of relationship, the most likely explanation the thesis can offer, based on literature reviewed, is that it varies heavily based on wealth of the nation, and as some studies also implied institutional factors as well.

As for the yields themselves, the theoretical part established two things. First, the relationship between yield spreads and economic growth rate is robust, attested, and trusted by academia and policymakers. Second, the bond yields themselves have a very variable relationship with growth rate, without consistency in either causality side or direction, although supply-side causality had an edge here as well.

The empirical analysis was conducted by creating a dataset of four variables. 10-year bond yields represented the long-term government bonds, % growth in GDP per capita represented the economic growth rate, and furthermore debt-to-GDP ratio and Gini coefficient were added due to literature suggesting existence of relationships. The dataset included 15 OECD countries, mostly the ones from Europe. The time period of the data spanned from 1995 to 2019. To analyse the relationship, the author employed non-parametric correlation testing, partial correlations, and panel Granger test to answer the question of causality. The results, more or less, aligned with the established literature. However, even though literature attests to relationship between growth rate and inequality, in this thesis the Gini coefficient did not correlate with the economic growth rate variable. Furthermore, debt-to-GDP and economic growth rate correlated to each other negatively when the literature would generally suggest otherwise. In terms of causality, all that was detected was 10-year yield rates having a Granger causality over economic growth, at a 10% significance only. Yet

again, it mostly aligns with the supply-leading theory, but the thesis has not conducted enough research to directly reject the notions of bidirectional, or demand-leading theories.

In short, the thesis found a mono-directional, supply-leading, causal relationship between long-term government bond yields and economic growth rate, with the correlation testing suggesting that general relationship between the two variables is of positive direction.

The future recommendations for this topic would be, first of all, to increase the dataset and examine a greater period of time and more countries. More importantly, a more diverse set of countries, as the dataset used in the thesis is far from being an accurate sample of the world economies.

List of references

1. Abdelkafi, I. (2016). The Relationship Between Public Debt, Economic Growth, and Monetary Policy: Empirical Evidence from Tunisia Author & abstract. *Journal of the Knowledge Economy, 9*(4), 1154-1167.

2. Afonso, A., Nunes, A. S. (2014) Economic forecasts and sovereign yields. *Economic Modelling 44*(2015), 319-326

3. Amadeo, K. (2020a) *Gross National Product and Its Differences from Gross Domestic Product.* Retrieved from https://www.thebalance.com/what-is-the-gross-national-product-3305847

4.Amadeo, K. (2020b) *Gross National Income*. Retrieved from https://www.thebalance.com/gross-national-income-4020738

5. Azzimonti, M., de Francisco, E., Quadrini, V. (2014). Financial Globalization, Inequality, and the Rising Public Debt. *American Economic Review, 104*(8), 2267-2302

6. Baldacci, E., Kumar, M.S. (2010). *Fiscal Deficits, Public Debt, and Sovereign Bond Yields* (IMF Working Paper 10/184).

7. Bhattacharyay, B. N. (2011) *Bond Market Development in Asia: An Empirical Analysis of Major Determinants.* (ADBI Working Paper No. 300)

8. Boland, V. (2017). *Ireland's 'de-globalised' data calculate a smaller economy*. Retrieved from https://www.ft.com/content/dd3a6f1c-6aea-11e7-bfeb-33fe0c5b7eaa

9. Borissov, K., Kalk, A. (2020) Public debt, positional concerns, and wealth inequality. *Journal of Economic Behavior & Organization, 170*(C), 96-111

10. Calderon, C., Rodrigo, F. J. (2013). *Government Debt and Economic Growth* (IDB Publications No.4641) .

11. Caner, M., Grennes, T., Koehler-Geib, F. (2010). *Finding the Tipping Point – When Sovereign Debt Turns Bad*. (World Bank Policy Research Working Paper No.5391.

12. Chen, J. (2019) *Brady Bonds*. Retrieved from https://www.investopedia.com/terms/b/bradybonds

13. Chinn, M., Kucko, K. (2015) The Predictive Power of the Yield Curve Across Countries and Time. *International Finance 18*(2), 129-156

14. CSO Ireland (2021) *Modified GNI.* Retrieved from https://www.cso.ie/en/releasesandpublications/ep/p-nie/nie2017/mgni/

15. Egbetunde, T. (2012). Public Debt and Economic Growth in Nigeria: Evidence from Granger Causality. *American Journal of Economics, 2*(6), 101-106.

16. Eichengreen, B., Luengnaruemitchai, P. (2004) *Why Doesn't Asia Have Bigger Bond Markets?* (NBER Working Paper No.10576)

17. Eichengreen, B., Borensztein, E., Panizza, U. (2006) *Debt Instruments and Policies in the New Millennium: New Markets and New Opportunities* (IDB Working Paper No. 465)

18. Eurostat (2021) *Gini coefficient of equivalised disposable income - EU-SILC survey.* Retrieved from https://ec.europa.eu/eurostat/web/products-datasets/-/tessi190

19. Eurostat (2021) *Long-term government bond yields.* Retrieved from https://ec.europa.eu/eurostat/web/products-datasets/-/teimf050

20. Fanta, A. B. (2017). Bond markets, stock markets, banks and growth: a system GMM analysis. *Global Business and Economic Review, 19*(1), 1-14

21. Ferreira, C. (2016). Debt and Economic Growth in the European Union: A Panel Granger Causality Approach. *International Atlantic Society 22*(2), 131-149.

22. Fink, G., Haiss, P. R., Hristorova, S. (2003) Bond Markets and Economic Growth. *Europainstitut Working Paper 149*

23. Foley, D. K. (2012). Dilemmas of Economic Growth. *Eastern Economic Journal*. *38*(3), 283-295.

24. Gargouri, I., Ksantini, M. (2016). The Determinants of Public Debt. *The Romanian Economic Journal, 59,* 111-124.

25. Hayes, A. (2019) *Genuine Progress Indicator (GPI).* Retrieved from: https://www.investopedia.com/terms/g/gpi.asp

26. Hirtenstein, A. (2020) *European Union Moves Closer to Common Debt Issuance.* Retrieved from: https://www.wsj.com/articles/european-union-moves-closer-to-common-debt-issuance-11602087285

27. Jacobs, J., Ogawa, K., Sterken, E., Tokutsu, I. (2019). Public Debt, Economic Growth and the Real Interest Rate: A Panel VAR Approach to EU and OECD Countries. *Applied Economics, 52*(1), 1377-1394

28. Kapingura, F., Makheta-Kosi, P. (2014). The Causal Relationship between the Bond Market Development and Economic Growth in Africa: Case Study of South Africa. *Mediterranean Journal of Social Sciences, 5*(3), 126-131

29. Kramer, L. (2020) *What Is GDP and Why Is It So Important to Economists and Investors?* Retrieved from https://www.investopedia.com/ask/answers/what-is-gdp-why-its-important-to-economists-investors/

30. Kumar, M.S., Woo, J. (2010). *Public Debt and Growth* (IMF Working Paper No.10/174).

31. Masoud N. M. H. (2013) Stock Markets: A Catalyst for Economic Growth *International Journal of Finance & Banking Studies 2*(4) 13-29

32. Matei, I. (2012). Euro Zone Bond Market and Economic Growth: Evidence from a Time Series Analysis. *Recent Developments in Alternative Finance: Empirical Assessments and Economic Implications,* 39-51

33. Matei, I. (2014) FINANCE AS A DRIVER OF GROWTH? EVIDENCE FROM EU COUNTRIES. *Revue d'économie politique 124*(4), 571-586

34. Milanovic, B. (2019) *All the Ginis (ALG) Dataset.* Retrieved from https://stonecenter.gc.cuny.edu/researchAll%20the%20Ginis%20(ALG)%20Dataset/all-the-ginis-alg-dataset-version-february-2019/

35. Mu, Y., Phelps, P., Stotsky, J. G. (2013) *Bond Markets in Africa* IMF Working Paper

36. Ncube, M., Anyanwu, J. C., Hausken, K. (2014). Inequality, Economic Growth and Poverty in the Middle East and North Africa (MENA). *African Development Review, 26*(3), 435-453

37. Nguyen, T. M. H., Nguyen N. T. (2019). Bond Market Development and Economic Growth: An Empirical Study in Asia.

38. OECD (2012) Debt and Macroeconomic Stability *OECD Economics Department Policy Notes 16*

39. OECD (2021) *General Government Debt* Retrieved from https://data.oecd.org/gga/general-government-debt.htm

40. OECD (2021) *Income Inequality.* Retrieved from https://data.oecd.org/inequality/income-inequality.htm

41. OECD (2021) *Long-term Interest Rates.* Retrieved from https://www.oecd-ilibrary.org/content/data/662d712c-en

42. OECD (2021) Main Economic Indicators *OECD Publishing 2021*(4)

43. Pradhan, R. P., Arvin, M. B., Bennett, S. E., Nair, M., Hall, J. H. (2016). Bond Market Development, Economic Growth and Other Macroeconomic Determinants: Panel VAR Evidence. *Asia-Pacific Financial Markets, 23,* 175-201.

44. Pradhan, R. P., Arvin, M. B., Norman, N. R., Bahmani, S. (2018) The dynamics of bond market development, stock market development and economic growth -Evidence from the G-20 countries. *Journal of Economics, Finance and Administrative Science 25*(49), 119-147

45. Rahandusministerium (2021) *Debt Management*. Retrieved from https://www.rahandusministeerium.ee/en/objectivesactivities/state-treasury/financial-reserves-and-liabilities/debt-management

46. Rahman, N., Nower, N., Abbas, S.M., Nahian, A. H., Tushar, R. H. (2020). *Introduction of Bond Market: Would it be a possible Solution for Bangladesh?* Retrieved from https://mpra.ub.uni-muenchen.de/101159/

47. Ranasinghe, D., Rao, S. (2020) *U.S. Treasury yields tumble, curve inversion deepens as coronavirus spreads*. Retrieved from https://www.reuters.com/article/us-china-health-markets-treasuries-idUSKCN20I18U

48. Reiner, E. L. (2006) *Treasury Brings Back The 30-year Bond.* Retrieved from https://www.fa-mag.com/news/article-1305.html

49. Ribeiro R. S. M., McCombie J. S. L., Lima G. T. (2020) Does real exchange rate undervaluation really promote economic growth? *Structural Change and Economic Dynamics 52* 408-417

50. Ritter, J. R. (2012) Is Economic Growth Good for Investors? *Journal of Applied Corporate Finance 24*(3), 8-18

51. Shaukat, B., Zhu, Q., Khan, M. I. (2019) Real interest rate and economic growth: A statistical exploration for transitory economies. *Physica A: Statistical Mechanics and its Applications 534*(C)

52. Shin, I. (2012) Income inequality and economic growth. *Economic Modelling 29*(5), 2049-2057

53. Smaoui, H., Grandes, M., Akindele, A. (2017) The Determinants of Bond Market Development: Further Evidence from Emerging and Developed Countries, *Emerging Markets Review 32* 148-167

54. Sutherland, D., Hoeller, P. (2012). Debt and Macroeconomic Stability: An Overview of the Literature and Some Empirics. *OECD Economics Department Working Papers 1006*

55. Taivan, A., Donayre, L. (2017). Causality between Public Debt and Real Growth in the OECD: A Country-by-country Analysis. *Economic Papers, 36*(2), 156-170

56. Thumrongvit, P., Kim, Y., Pyun, C. S. (2013) Linking the missing market: the effect of bond markets on economic growth. *International Review of Economics and Finance 27*(2013) 529-541

57. Verriet, J., Bosch, R. (2012) *Long-Term Government Bond Yield.* Retrieved from https://clio-infra.eu/Indicators/LongTermGovernmentBondYield.html#

58. Worldbank (2021) *GDP per capita growth (annual %).* Retrieved from https://data.worldbank.org/indicator/NY.GDP.PCAP.KD.ZG?end=2019&start=1961

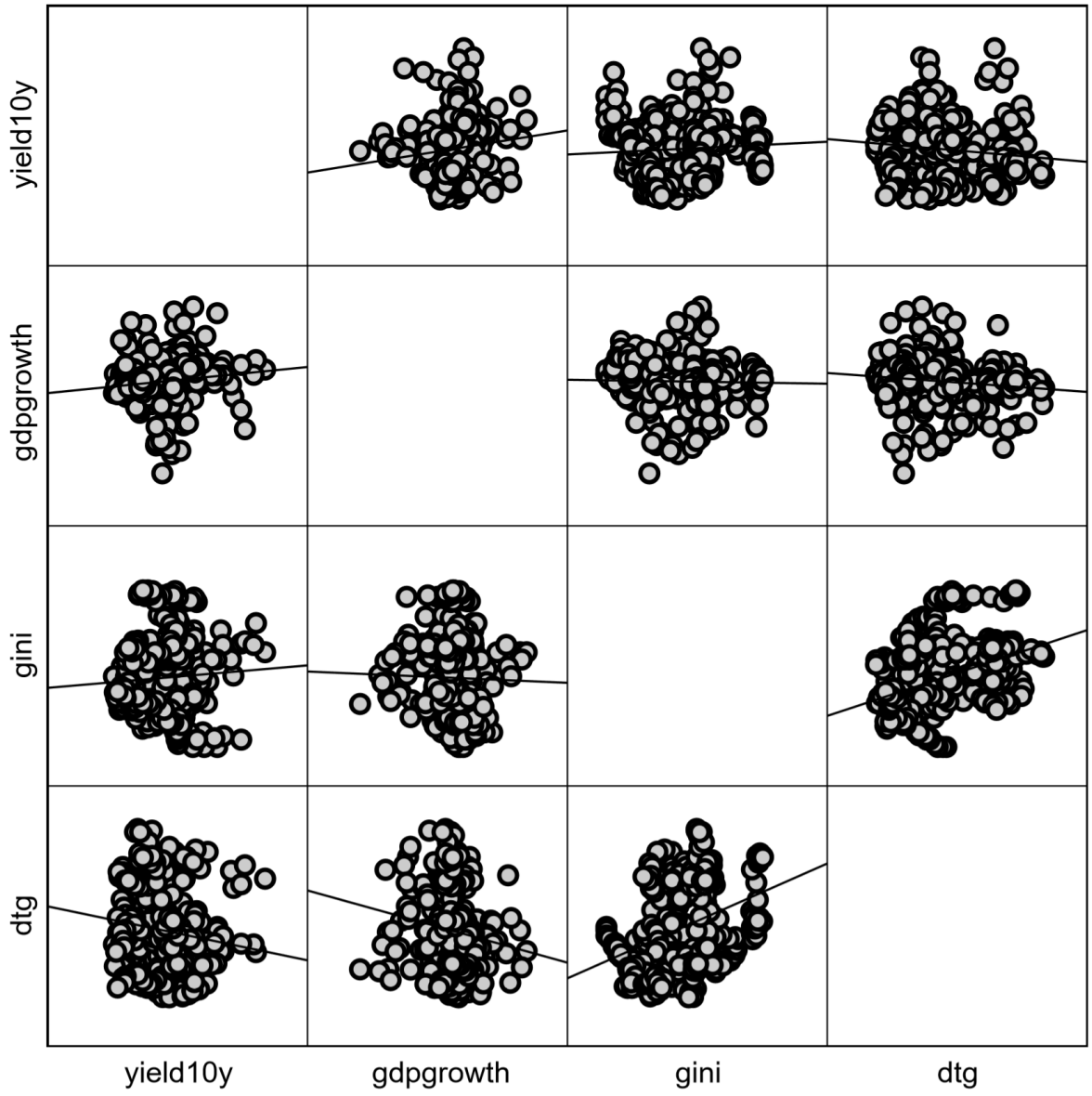
59. Worldbank (2021) *Gini index (Worldbank Estimate).* Retrieved from https://data.worldbank.org/indicator/SI.POV.GINI

60. Zada, E.R., Gatto, A. (2019). *Determinants of the Public Debt and the Role of the Natural Resources.* Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3364174

APPENDICES

APPENDIX A

Scatter plot matrix for observed variables



Note. dtg = Debt-to-GDP ratio

APPENDIX B

Correlations

			10-Year Yield Rate	Debt-to-GDP ratio	% Growth in GDP Per capita
Kendall's tau_b	10-Year Yield Rate	Correlation Coefficient	1		
		Sig. (2-tailed)			
		N	375		
	Debt-to-GDP ratio	Correlation Coefficient	**-.100****	1	
		Sig. (2-tailed)	0.004008576		
		N	375	375	
	% Growth in GDP Per capita	Correlation Coefficient	**.161****	**-.119****	1
		Sig. (2-tailed)	0.000	0.000566	
		N	375	375	375
	Gini Coefficient	Correlation Coefficient	0.030355896	**.276****	-0.02
		Sig. (2-tailed)	0.382904131	0.000	0.54
		N	375	375	375
Spearman's rho	10-Year Yield Rate	Correlation Coefficient	1		
		Sig. (2-tailed)			
		N	375		
	Debt-to-GDP ratio	Correlation Coefficient	**-.159****	1	
		Sig. (2-tailed)	0.001960921		
		N	375	375	
	% Growth in GDP Per capita	Correlation Coefficient	**.251****	**-.180****	1
		Sig. (2-tailed)	0.000	0.000473	
		N	375	375	375
	Gini Coefficient	Correlation Coefficient	0.05	**.407****	-0.03
		Sig. (2-tailed)	0.33	0.000	0.5
		N	375	375	375

Source: Author's calculations

Resümee

VALITSUSE PIKAAJALISTE VÕLAKIRJADE TOOTLUSE JA MAJANDUSLIKU KASVUMÄÄRA VAHELINE SUHE

Alexander Katamadze

Kuna nii paljud aspektid sõltuvad riigi majandusest - kodanike jõukus, valitsuse stabiilsus, elukvaliteet ja paljud muud tegurid -, pole üllatav, et majanduskasv, selle mõjud ja tõukejõud on sageli uuritud. Seda arvestades, on see lõputöö lihtsalt üks paljudest. Tähelepanuväärseks teeb selle aga külg, millest seda küsimust uuritakse. Kui sageli uuritakse majanduse ja aktsiaturu suhet, siis teistele finantsturgudele pööratakse vähem tähelepanu. Ja isegi kui nad seda teevad, vaadeldakse ainult finantsturu kasvu või võlakirjade tootluse suunda. Selles dokumendis käsitletakse pigem majanduse ja valitsuse pikaajaliste võlakirjade tootluse kasvumäärade vahelist suhet, eesmärgiga uurida selle suunda, päritolu ja tugevust, et aidata kaasa majanduskasvu käsitlevale kirjandusele.

See lõputöö algas varasema kirjanduse ülevaatamisega majanduse ja võlakirjaturgudega seotud teemadel, millest esimene oli riigivõlg ja selle mõju majandusele. See leidis, et kuigi seda suhet sageli demonstreeritakse ja enamasti samade tulemustega, võib siiski leida selle erinevaid tõlgendusi. Täpsemalt arutatakse selle üle, milline neist kahest muutujatest teist mõjutab, ja millal on võlg hea. Järgmine teema, mida vaadati, oli võlakirjaturgude areng. Selles osas olid tulemused järjepidevamad. Autorid nõustusid, et võlakirjaturul ja majanduskasvul olid positiivsed suhted ning enamik, kuid mitte kõik autorid väitsid ka, et just võlakirjaturud mõjutasid majanduskasvu. Ja viimases peatükis puudutas kirjanduse ülevaade tootluse ja tootlussuuna teemat. Siit leiti, et tootlussuundasi peeti peaaegu ühehäälselt suurepäraseks vahendiks majanduse muutuste prognoosimisel, kuid tootlusmäärade uurimisel olid tulemused kõikjal levinud ning avastati kummalisi suundumusi, mis sarnanesid sissetulekute ebavõrdsusele. Üldiselt jõuti selles teoreetilises ülevaates järeldusele, et võla ja võlaga seotud muutujate ning majanduskasvu vahel on tugev seos, kuid see näitas ka, et selle täpsete üksikasjade osas on palju ebakindlust.

Mis puutub empiirilistesse uuringutesse, siis 25 aasta jooksul koguti 15 riigi kohta neli muutujat. Võlakirjade tootluse andmed koguti 10-aastaste võlakirjade tootluse, SKT kasvumäära elaniku kohta ja võla suhte SKT-u ja Gini koefitsiendi kohta, mis mõõdab sissetulekute ebavõrdsust. Andmekogum oli väga mitteparameetriline ja seos põhimuutujate vahel oli väga mittelineaarne. Sel põhjusel välditi lineaarset regressiooni ja selle asemel kasutati andmekogumi analüüsimiseks mitteparameetrilisi teste, mis leidsid nõrga, kuid positiivse seose tootluse ja majanduskasvu vahel. Põhjuslikkust uuriva Grangeri testiga leiti,

et tootlusmääradel oli põhjuslik mõju majanduskasvule. Üldiselt on selle lõputöö järeldused kooskõlas olemasoleva kirjandusega, aidates seeläbi kaasa kindla konsensuse tekkimisele.

Non-exclusive licence to reproduce thesis and make thesis public

I, Alexander Katamadze,

1. herewith grant the University of Tartu a free permit (non-exclusive licence) to

reproduce, for the purpose of preservation, including for adding to the DSpace digital archives until the expiry of the term of copyright,

RELATIONSHIP BETWEEN LONG-TERM GOVERNMENT

BOND YIELDS AND ECONOMIC GROWTH

supervised by Mark Kantšukov.

2. I grant the University of Tartu a permit to make the work specified in p. 1 available to the public via the web environment of the University of Tartu, including via the DSpace digital archives, under the Creative Commons licence CC BY NC ND 3.0, which allows, by giving appropriate credit to the author, to reproduce, distribute the work and communicate it to the public, and prohibits the creation of derivative works and any commercial use of the work until the expiry of the term of copyright.

3. I am aware of the fact that the author retains the rights specified in p. 1 and 2.

4. I certify that granting the non-exclusive licence does not infringe other persons' intellectual property rights or rights arising from the personal data protection legislation.

Alexander Katamadze
13/05/2021